

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Appln. of: KIKKAWA et al.

Serial No.: 09/690,330

Filed: October 17, 2000

For: REFLECTION-TYPE COLOR LIQUID CRYSTAL DISPLAY ...

Art Unit: 2871

Examiner: THOI V. DUONG

DOCKET: NEC 00FN054

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**VERIFICATION OF TRANSLATION**

The undersigned hereby certifies that I am conversant in both the Japanese and English languages, that I have prepared the attached English translation of Japanese Patent Application Serial No. 11-296002, filed October 18, 1999, (the '002 Japanese Application) and that the attached English translation is a true, faithful and accurate translation of the '002 Japanese Application.

I further declare that all statements made of my own knowledge are true and that all statements made on information and belief are with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 USC § 1001, and that such false statements may jeopardize the validity of the Application or any patent issuing therefrom.

Date November 6, 2003

Signature

Typed Name: Masanori FUJIMAKI

Address: 39-12, Shinsakuragaoka 1-chome, Hodogaya-ku, Yokohama-shi,

Kanagawa 240-0036, Japan

AYES SOLOWAY P.C.

130 W. CUSHING ST.  
TUCSON, AZ 85701  
TEL. 520.882.7623  
FAX. 520.882.7643

175 CANAL STREET  
MANCHESTER, NH 03101  
TEL. 603.668.1400  
FAX. 603.668.8567



PATENT OFFICE JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application: October 18, 1999

Application Number: Application for Patent  
Hei 11-296002

Applicant(s): NEC Corporation

July 14, 2000

Commissioner, Kozo OIKAWA (Seal)  
Patent Office

Certification No. 2000-3055232



[Name of the Document] PATENT APPLICATION  
[Docket Number] 74610397  
[Date of Filing] October 18, 1999  
[Addressee] Commissioner, Patent Office  
[International Patent Classification] G02F 01/1335  
[Inventor]  
[Address or Residence] c/o NEC Corporation, 7-1,  
Shiba 5-chome, Minato-ku, Tokyo, Japan.  
[Name] Hironori KIKKAWA  
[Inventor]  
[Address or Residence] c/o NEC Corporation, 7-1,  
Shiba 5-chome, Minato-ku, Tokyo, Japan.  
[Name] Mamoru OKAMOTO  
[Inventor]  
[Address or Residence] c/o NEC Corporation, 7-1,  
Shiba 5-chome, Minato-ku, Tokyo, Japan.  
[Name] Yuji YAMAMOTO  
[Inventor]  
[Address or Residence] c/o NEC Corporation, 7-1,  
Shiba 5-chome, Minato-ku, Tokyo, Japan.  
[Name] Michiaki SAKAMOTO  
[Inventor]  
[Address or Residence] c/o NEC Corporation, 7-1,  
Shiba 5-chome, Minato-ku, Tokyo, Japan.  
[Name] Muneo MARUKAWA  
[Inventor]  
[Address or Residence] c/o NEC Corporation, 7-1,  
Shiba 5-chome, Minato-ku, Tokyo, Japan.  
[Name] Takahiko WATANABE  
[Applicant]  
[Identification Number] 000004237  
[Name or Trade name] NEC Corporation  
[Attorney]  
[Identification Number] 100099830  
[Patent Attorney]  
[Name] Yukuo NISHIMURA  
[Phone No.] 048-825-8201  
[Indication of the Official Fee]  
[Deposit Register Number] 038106  
[Paid Amount] 21000  
[List of the Submitted Articles]  
[Name of Article] Specification 1  
[Name of Article] Drawing 1  
[Name of Article] Abstract 1  
[General Power of Attorney Number] 9407736  
[Proof] Necessary



[NAME OF DOCUMENT] Specification

[TITLE OF THE INVENTION] REFLECTION-TYPE COLOR LIQUID  
CRYSTAL DISPLAY APPARATUS AND METHOD FOR MANUFACTURING THE  
SAME

5 [CLAIMS]

[Claim 1] A reflection-type color liquid crystal display apparatus wherein a liquid crystal is sandwiched between a driving element formation substrate and an opposite substrate and a color filter is provided on said 10 driving element formation substrate, characterized in that light scattering means are provided at the liquid crystal side surface of said opposite substrate.

[Claim 2] The reflection-type color liquid crystal display apparatus according to claim 1, wherein said 15 opposite substrate has a transparent insulation substrate, and said light scattering means comprises an uneven portion formed at the surface of the liquid crystal side of said transparent insulation substrate.

[Claim 3] The reflection-type color liquid crystal display apparatus according to claim 2, wherein said light 20 scattering means comprises a flattened film formed to cover the uneven portion formed at the surface of the transparent insulation substrate.

[Claim 4] The reflection-type color liquid crystal display apparatus according to claim 1, wherein said 25 opposite substrate has a transparent insulation substrate, and said light scattering means comprises an uneven insulation film formed on the surface of the liquid crystal

side of the transparent insulation substrate.

[Claim 5] The reflection-type color liquid crystal display apparatus according to claim 4, wherein said light scattering means comprises a scattering auxiliary film 5 formed on the uneven insulation film and having a refractive index different from that of the uneven insulation film.

[Claim 6] The reflection-type color liquid crystal display apparatus according to claim 5, wherein said 10 refractive index of the uneven insulation film is larger than that of the scattering auxiliary film.

[Claim 7] The reflection-type color liquid crystal display apparatus according to claim 4, wherein said light scattering means comprises a flattened film formed to cover 15 the uneven insulation film.

[Claim 8] The reflection-type color liquid crystal display apparatus according to claim 4, wherein said light scattering means comprises a flattened and scattering auxiliary film formed to cover the uneven insulation film.

20 [Claim 9] A method for manufacturing a reflection-type color liquid crystal display apparatus, wherein a liquid crystal is sandwiched between a liquid crystal driving element formation substrate and an opposite substrate, and a color filter is provided on the liquid crystal driving element formation substrate; the method comprising the steps 25 of:

forming a liquid crystal driving element on a first transparent insulation substrate and then, forming at least

a color filter on the transparent insulation substrate to form a liquid crystal driving element formation substrate;

providing a light scattering means at a surface of a second transparent insulation substrate to form an opposite 5 substrate; and

sandwiching a liquid crystal between the liquid crystal driving element formation substrate and the opposite substrate by arranging the surface of the opposite substrate where the light scattering means is provided is positioned 10 on the side of the liquid crystal.

[Claim 10] The method for manufacturing the reflection type color liquid crystal display apparatus according to claim 9, wherein the light scattering means comprises an uneven portion.

15 [Claim 11] The method for manufacturing the reflection-type color liquid crystal display apparatus according to claim 10, wherein the uneven portion is formed by the process method including a sand blast method or a photo-etching method.

20 [DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Field of the Invention]

The present invention relates to a reflection-type color liquid crystal display apparatus and a method for 25 manufacturing the same. More particularly, the invention relates to a reflection-type color liquid crystal display apparatus and a method for manufacturing the same, wherein a color filter is provided on a substrate where a liquid

crystal driving element is formed.

[0002]

[Prior Art]

As display apparatuses for various information 5 apparatuses or the like, reflection-type color liquid crystal display apparatuses are widely used. Fig. 14 is a sectional view showing a structure of one example of a conventional reflection-type color liquid crystal display apparatus. The conventional reflection-type color liquid 10 crystal display apparatus comprises, as shown in Fig. 14, a liquid crystal driving element formation substrate 101 on which a thin film transistor (TFT) serving as a switching element (a driving element) for driving a liquid crystal is formed, an opposite substrate 102 which is opposed to the 15 substrate 101, and a liquid crystal 103 sandwiched between both the substrates 101 and 102.

[0003]

The liquid crystal driving element formation substrate 101 comprises, as shown in Fig. 14, a transparent insulation 20 substrate 104 made of glass or the like; a gate electrode 105 and a reflection plate 106 formed of aluminum, aluminum alloy or the like, which is formed on the transparent substrate 104; a gate insulation film 107 formed of silicon nitride or the like, which is formed on the gate electrode 25 105 and the reflection plate 106; a semiconductor layer 108 formed of an amorphous silicon or the like, which is formed on the gate insulation film 107 above the gate electrode 105; a drain electrode 109 and a source electrode 110 formed

of chromium or the like, which are connected to both ends of the semiconductor layer 108, respectively; and an insulation protection film 111 formed of silicon nitride or the like, which covers the drain electrode 109, the semiconductor 5 layer 108 and the source electrode 110. The gate electrode 105, the gate insulation film 107, the semiconductor layer 108, the drain electrode 109 and the source electrode 110 constitute the TFT.

[0004]

10 Furthermore, the liquid crystal driving element formation substrate 101 comprises a black matrix 112 formed on the insulation protection film 111, for preventing the incidence of light into the TFT and shielding light at a portion which is not associated with display; a color filter 15 113 formed on the insulation protection film 111; an insulation protection film 114 made of acryl polymer or the like, which covers the black matrix 112 and the color filter 113; a contact hole 117 formed in the insulation protection film 111, the black matrix 112 and the insulation protection 20 film 114 so as to reach the source electrode 110, a pixel electrode 115 formed of ITO (Indium Tin Oxide) which is formed on the insulation protection film 114 so as to be connected to the source electrode 110 via the contact hole 117; and a liquid crystal orientation layer 116 formed of 25 polyimide or the like, which is formed on the pixel electrode 115.

[0005]

Furthermore, the opposite substrate 102 comprises a

transparent insulation substrate 121 formed of glass or the like; a common opposite electrode 122 formed of ITO or the like which is formed on the transparent insulation substrate 121; and a liquid crystal orientation layer 123 formed of 5 polyimide or the like, which is formed on the opposite electrode 122.

[0006]

According to the conventional reflection-type color liquid crystal display apparatus having the above structure, 10 since the black matrix 112 and the color filter 113 are formed on the liquid crystal driving element formation substrate 101, an overlap margin is not required to be taken wherein a deviation of both the substrates 101 and 102 are considered in the case of assembling the reflection-type 15 color liquid crystal display apparatus by sandwiching the liquid crystal 103 between the liquid crystal driving element formation substrate 101 and the opposite substrate 102, so that an opening ratio can be enlarged as compared with other structures in which the black matrix 112 and the 20 color filter 113 are formed on the opposite substrate 102, and brighter display can be provided.

[0007]

In the reflection-type color liquid crystal display apparatus having the structure described above, light 25 scattering means for scattering light incident from the side of the opposite substrate 102 is required especially when a white color is displayed.

For example, Japanese Patent Application Laid-Open No.

hei 11-84415 discloses one example of a reflection-type color liquid crystal display apparatus which provides a white color display as described above. Fig. 15 is a sectional view showing a structure of another conventional 5 reflection-type color liquid crystal display apparatus. As shown in Fig. 15, the another conventional reflection-type color liquid crystal display apparatus is constituted such that a light scattering plate 125 is provided outside of the transparent insulation substrate 121 of the opposite 10 substrate 102. In other words, the another conventional reflection-type color liquid crystal display apparatus allows the light scattering plate 125 provided outside of a panel of the opposite substrate 102 to function as light scattering means to provide a white color display. Except 15 for the above, the constitution shown in Fig. 2 is approximately the same as that shown in Fig. 14, so that respective portions of Fig. 15 corresponding to those of the conventional reflection-type color liquid crystal display apparatus shown in Fig. 1 are denoted with same reference 20 numerals, and an explanation thereof will be omitted here.

[0008]

[Problem to be solved by the invention]

However, since the conventional reflection-type color liquid crystal display apparatus is provided with the light 25 scattering means outside of the opposite substrate, there is a problem that the starting point of scattering is set at a point distant from the liquid crystal so that the contrast is lowered.

Figs. 17 and 18 are sectional views for schematically explaining the reason why the contrast is lowered in the conventional reflection-type color liquid crystal display apparatus. In the case where the scattering plate 125 serving as the light scattering means is provided outside of the opposite substrate 102, light 131A, 131B, 131C, 131N incident on a specific incident light region 130 from the outside are irregularly reflected at a boundary portion between the scattering plate 125 and the opposite substrate 102 to be spread in a radial configuration, as shown in Fig. 17. Then, after part of the irregularly reflected light is incident on the end portion of a R pixel 113R of a color filter 113 through a liquid crystal 103R (Red), for example, it is reflected by the reflection plate 106 to pass through a B(Blue) 113B which is adjacent to the R pixel, and the light is emitted as abnormal light 131X. Essentially, it is desired that, after the light incident on the R pixel 113R is reflected by the reflection plate 106, the light passes only through the R pixel 113R and it is emitted as normal light 131Z. As apparent from what has been described above, the specific incident light region 130 causes the generation of color mixing or uncontrollable light.

[0009]

The fact that light passes through two color filters like light 134 means that a color mixing is generated. On a pixel region on which red color is to be essentially displayed, the mixed color of red and blue colors is displayed. Furthermore, the light 131X passes through the

two pixel regions with the result that uncontrollable light 135 in which a phase difference cannot be predicted is generated, because the light passes through liquid crystals 103R and 103B and are controlled differently each other.

5 Consequently, the luminance at the time of black display will rise, for example, even if the color filter 113R of the R pixel attempts to provide a black display. The degree of such color mixing and the degree of the generation of uncontrollable light become large with an increase in light 10 which traces the same path as the abnormal light 131X described above with the result that the hue reproduction zone is narrowed and the contrast is lowered. The lowering of the contrast becomes more remarkable as the starting point of scattering generated by the scattering plate 125, 15 namely the position where the scattering plate 125 exists becomes distant from the liquid crystal 103.

[0010]

Furthermore, in the reflection-type color liquid crystal display apparatus having the conventional structure, 20 the visibility of the emitted light is deteriorated. Fig. 16 is a sectional view schematically explaining the reason why the visibility is deteriorated in the conventional reflection-type color liquid crystal display apparatus.

In the case where an observer observes a view from a 25 front surface position 132, light reflected by the reflection plate 106 to be emitted includes generation of light 137 which is directed in a slanting direction from the boundary of the pixel except for the light 133 which is

directed to the front surface position 132 with the result that this light 137 is scattered with the scattering plate 125 and part of this light 137 becomes light 135 which is directed toward the front surface position 132.

5 Consequently, an observer comes to observe displayed image which is deviated by a distance between the light 133 and the light 135, so that the observer observes a blurred double image thereby deteriorating the visibility thereof.

[0011]

10 It is an object of the present invention to provide a reflection-type color liquid crystal display apparatus and a method for manufacturing the same, wherein contrast and visibility can be improved in a case where a white color is displayed by providing light scattering means.

15 [0012]

[Means to solve the Problem]

To solve the above-noted problem, a present invention of claim 1 is a reflection-type color liquid crystal display apparatus where a liquid crystal is sandwiched between a 20 liquid crystal driving element formation substrate and an opposite substrate and a color filter is provided on the liquid crystal driving element formation substrate, characterized in that light scattering means is provided on the side of the liquid crystal of the opposite substrate.

25 [0013]

The invention of claim 2 is, in the reflection-type color liquid crystal display apparatus of claim 1, the light scattering means comprises an uneven portion formed at a

surface of a transparent insulation substrate which constitutes the opposite substrate. Said surface where the uneven portion is formed, is positioned on the side of the liquid crystal.

5 [0014]

The invention of claim 3 is, in the reflection-type color liquid crystal display apparatus of claim 2, the light scattering means comprise a flattened film formed to cover the uneven portion formed at the surface of the transparent 10 insulation substrate.

[0015]

The invention of claim 4 is, in the reflection-type color liquid crystal display apparatus of claim 1, said light scattering means comprise an uneven insulation film 15 formed on the surface of the liquid crystal side of the transparent insulation substrate.

[0016]

The invention of claim 5 is, in the reflection-type color liquid crystal display apparatus of claim 4, the light 20 scattering means comprise a scattering auxiliary film formed on the uneven insulation film, having a different refractive index from that of the uneven insulation film.

[0017]

The invention of claim 6 is, in the reflection-type 25 color liquid crystal display apparatus of claim 5, the refractive index of the uneven insulation film is larger than that of the scattering auxiliary film.

[0018]

The invention of claim 7 is, in the reflection-type color liquid crystal display apparatus of claim 4, the light scattering means have a flattened film formed to cover the uneven insulation film.

5 [0019]

The invention of claim 8 is, in the reflection-type color liquid crystal display apparatus of claim 4, the light scattering means have a flattened and scattering auxiliary film formed to cover the uneven insulation film.

10 [0020]

The invention of claim 9 is a method for manufacturing a reflection-type color liquid crystal display apparatus, wherein a liquid crystal is sandwiched between a liquid crystal driving element formation substrate and an opposite substrate, and a color filter is provided on the liquid crystal driving element formation substrate; the method comprising the steps of: forming a liquid crystal driving element on a first transparent insulation substrate and then, forming at least a color filter on the transparent insulation substrate to form a liquid crystal driving element formation substrate; providing a light scattering means at a surface of a second transparent insulation substrate to form an opposite substrate; and sandwiching a liquid crystal between the liquid crystal driving element formation substrate and the opposite substrate by arranging the surface of the opposite substrate where the light scattering means is provided is positioned on the side of the liquid crystal.

[0021]

The invention of claim 10 is, in the reflection-type color liquid crystal display apparatus of claim 9, the light scattering means comprises an uneven portion.

5

[0022]

The invention of claim 11 is, in the reflection-type color liquid crystal display apparatus of claim 10, the uneven portion is formed by a processing method including, for example, a sand blast method, or a photo-etching method.

10

[0023]

[Embodiment of the Present Invention]

Next, embodiments of the present invention will be described in detail hereinbelow with referring to the accompanied drawings.

15

◇First Embodiment

Fig. 1 is a plan view showing a structure of a reflection-type color liquid crystal display apparatus according to a first embodiment of the present invention.

Fig. 2 is a sectional view taken along line A-A of Fig. 1.

20

Fig. 3 is a sectional view for schematically explaining a reason why contrast is improved in the reflection-type color liquid crystal display apparatus according to the first embodiment. Fig. 4 is a sectional view for schematically explaining a reason why visibility is excellent with the reflection-type color liquid crystal display apparatus according to the first embodiment. Fig. 5 and Fig. 6 are sectional views showing the method for manufacturing the reflection-type color liquid crystal display apparatus

25

according to the first embodiment in order of steps. Fig. 7 and Fig. 8 are views showing one example of the process method for forming light scattering means in the method for method for manufacturing the reflection-type color liquid 5 crystal display apparatus according to the first embodiment.

As shown in Figs. 1 and 2, the reflection-type color liquid crystal display apparatus of the embodiment comprises a liquid crystal driving element formation substrate 1 on which a TFT is formed which operates as a switching element 10 (a driving element), an opposite substrate 2, and a liquid crystal 3 sandwiched between substrates 1 and 2.

[0024]

In the liquid crystal driving element formation substrate 1, as shown in Figs. 1 and 2, a first transparent 15 insulation substrate 4 is formed of glass or the like. A gate electrode 5 and the reflection plate 6 is made of aluminum or aluminum alloy and formed on the first transparent insulation substrate 4. On the gate electrode 5 and the reflection plate 6, a gate insulation film 7 is 20 formed of silicon nitride or the like. On the gate insulation film 7 above the gate electrode 5, a semiconductor layer 8 is formed of amorphous silicon or the like. From both ends of the semiconductor layer 8, a drain electrode 9 and a source electrode 10 formed of chromium or 25 the like are extracted, and an insulation protection film 11 is formed to cover the drain electrode 9, the semiconductor layer 8 and the source electrode 10. This insulation protection film 11 is made of silicon nitride or the like.

Here, the gate electrode 5, the gate insulation film 7, the semiconductor layer 8, the drain electrode 9 and the source electrode 10 constitutes the TFT.

[0025]

5 Furthermore, in the liquid crystal driving element formation substrate 1, a black matrix 12 is formed on the insulation protection film 11 for preventing the incidence of light into the TFT and shielding a light at a portion which is not associated with the display. A color filter 13  
10 is formed on the insulation protection film 11. An insulation protection film 14 made of acryl polymer or the like is formed so as to cover the black matrix 12 and the color filter 13. In the insulation protection film 11, the black matrix 12 and the insulation protection film 14, a  
15 contact hole 17 is formed which attains the source electrode 10. On the insulation protection film 14, the pixel electrode 15 is formed so as to be connected to the source electrode 10 via the contact hole 17. The pixel electrode is made of ITO. On the pixel electrode 15, a liquid crystal  
20 orientation layer 16 is formed of polyimide or the like.

[0026]

Furthermore, in the opposite substrate 2, an uneven portion 24 is formed on the surface of a second transparent insulation substrate 21 formed of glass or the like on the  
25 side of the liquid crystal 3. A flattened film 25 made of acryl, polyimide or the like is formed to cover the uneven portion 24 of the second transparent insulation substrate 21. On the flattened film 25, a common opposite electrode 22 is

formed of ITO or the like. A liquid crystal orientation layer 23 is formed of polyimide or the like on the opposite electrode 22.

The uneven portion 24 of the second transparent  
5 insulation substrate 21 is covered with the flattened film  
25 and constitutes light scattering means. In other words,  
the first embodiment is characterized in that light  
scattering means is provided on the side of the liquid  
crystal 3 of the opposite substrate 2.

10 [0027]

Here, since the height difference of the surface of the second transparent insulation substrate 21 renders the thickness of the liquid crystal 3 even, it is desired that the thickness is 1mm or less. For this purpose, the  
15 thickness of the flattened film 25 is required to be sufficient to cover the height difference of the uneven portion 24. Furthermore, it is desired that the height difference between a top portion 24A and a valley portion 24B is on the same level or not more than the thickness of  
20 the liquid crystal 3 (3 to 10  $\mu$ m). The reason is that in the case where the reflection-type color liquid crystal display apparatus is assembled by sandwiching the liquid crystal 3 between the liquid crystal driving element formation substrate 1 and the opposite substrate 2, the  
25 uneven portion 24 does not attain the liquid crystal driving element formation substrate 1 to damage the substrate 1 even if the uneven portion 24 is not sufficiently planarized owing to the failure of the flattened film 25. The uneven

portion 24 of the second transparent insulation substrate 21 is formed by the processing method such as the sand blast method or the photo-etching method and the like as described later.

5 [0028]

As described above, in the structure of the first embodiment, the light scattering means is provided on the side of the liquid crystal 3 of the opposite substrate 2 so that the starting point of scattering in the opposite substrate 2 can be set to a point near from the liquid crystal 3. Thus, the generation of undesirable light such as mixed color light or uncontrollable light is decreased and contrast can be improved because the starting point of scattering in the opposite substrate 2 can be set to a point 10 near from the liquid crystal 3. 15

[0029]

Fig. 3 is a view for schematically explaining the reason why the contrast is improved. In the first embodiment, the light scattering means comprising the uneven portion 24 and the flattened film 25 is provided on the side of the second transparent insulation substrate 21 with the result that the starting point of scattering is set to the point near from the liquid crystal 3 as apparent from the comparison between Fig. 3 and Fig. 17. Consequently, light 20 31A, 31B, 31C and 31D incident on the specific incident light region 30 is irregularly reflected with the uneven portion 24 constituting the light scattering means to be reflected with the reflection plate 6 with the result that 25

the light passes through a B(Blue) pixel which is adjacent to R(Red) pixel and is emitted as abnormal light 31X. As apparent from the comparison between Fig. 3 and Fig. 17, the quantity of abnormal light 31X decreases. On the other hand, 5 after the light is incident on the R pixel 13R to be reflected at the reflection plate 10, the quantity of normal light 31Z to be emitted only through the R pixel 13R increases. That is, the width of the specific incident light region which causes the generation of color mixing or 10 uncontrollable light is narrower than the conventional display apparatus. As a consequence, the degree of the generation of the color mixing or uncontrollable light can be made small. Therefore, contrast and visibility can be improved.

15 [0030]

Furthermore, according to the first embodiment, visibility can be improved in the case where light is emitted. Fig. 4 is a sectional view for schematically explaining the reason why visibility is improved.

20 In the case where the observer observes a view from the front surface position 32, light 34 is generated which is directed in a slanting direction from the boundary of the pixel except for light 33 which is directed toward the front surface position 32. This light 34 is scattered with the 25 uneven portion 24 of the second transparent insulation substrate 21, so that part of the light 34 is converted into unusual light 35 which is directed toward the front surface position 32. In this case, since the uneven portion 24 of

the second transparent insulation substrate 21 is formed on the side of the liquid crystal 3, and the starting point of scattering is set to a point near from the liquid crystal 3, the distance between light 33 and light 38 becomes small as 5 apparent from the comparison with Fig. 16. Thus, the blurred degree of the display image can be made small for that portion. Consequently, visibility can be improved.

[0031]

Next, by referring to the Fig. 5 and Fig. 6, a method 10 for manufacturing a reflection-type color liquid crystal display apparatus according to the first embodiment can be explained in order of steps.

In the beginning, as shown in Fig. 5(a), after an 15 aluminum film is formed on the whole surface of the first transparent insulation substrate 4 formed of glass or the like by the sputtering method, the aluminum film is patterned with the known photolithography method, and the gate electrode 5 and the reflection plate 6 having desired configurations are formed at the same time. Since aluminum 20 is a material which has a high reflectance, aluminum has an excellent characteristic as the reflection plate 6.

Incidentally, since pure aluminum easily generates hillock, it is preferable to use aluminum alloy which is mixed with other material such as several % of neodium or the like as a 25 reflection plate 6.

[0032]

Next, silicon nitride is deposited on the whole surface of the substrate 4 by the CVD (Chemical Vapor Deposition)

method to form a gate insulation film 7. Next, after an N-type amorphous silicon layer is formed on the whole surface of the substrate 4 by the CVD method, the amorphous silicon layer is patterned with the photolithography method, so that 5 a semiconductor layer 8 is formed on the gate insulation film 7 above the gate insulation electrode 5. Next, after the chromium layer is formed on the whole surface of the substrate 4 by the sputtering method, the chromium layer is patterned with the photolithography method to form the drain 10 electrode 9 and the source electrode 10. Next, the silicon nitride film is formed on the whole surface of the substrate 4 by CVD method to form an insulation protection film 11. This insulation protection film 11 is formed to protect the semiconductor layer 8 from the outside atmosphere. In the 15 procedure described above, the TFT is formed which comprises the gate electrode 5, the gate insulation film 7, the semiconductor layer 8, the drain electrode 9 and the source electrode 10 which are formed on the first transparent insulation protection film 4.

20

[0033]

Next, as shown in Fig. 5(b), after a black resist added with a black color pigment in, for example, acryl photosensitive polymer is applied on the whole surface of the substrate 4, a black resist film is patterned with the 25 photolithography method, a black matrix 12 is formed to cover the surface of the TFT. This black matrix 12 is not necessarily required in the case where the light endurance of the TFT is sufficiently high. For example, after a

resist added with red color, green-color, or blue-color pigments in, for example, acryl photosensitive polymer is applied on the whole surface of the substrate 4, the resist film is patterned with the photolithography method followed 5 by forming a color filter 13 on the insulation protection film 11. Next, on the black matrix 12 and the color filter 13, an insulation protection film 14 is formed of, for example, acryl polymer or the like. This insulation protection film 14 is formed to prevent the mixture of toxic 10 material such as ions or the like from the black matrix 12 and/or the color filter 13 into the liquid crystal 3 formed as described later.

[0034]

Next, after a contact hole 17 is formed which exposes 15 the source electrode 10 by the photolithography method in the black matrix 12 and the insulation protection film 14, an ITO film is formed on the whole surface of the substrate 4 including this contact hole 17 by the sputtering method followed by patterning the ITO film with the 20 photolithography method to form a pixel electrode 15 having a desired configuration. Next, a liquid crystal orientation layer 16 is formed of polyimide on the pixel electrode 15.

In the above procedure, a substrate 1 on which a liquid crystal driving element is formed is obtained.

25 [0035]

Next, as shown in Fig. 6(c), the surface (the surface which constitutes a side of a liquid crystal 3) of the second transparent insulation substrate 21 which is formed

of glass or the like and having a thickness of 0.5 to 1.5mm, is processed or worked to form an uneven portion 24. The uneven portion 24 is formed in such a manner that the height difference between a top portion 24A and a valley portion 5 24B becomes the same or not more than the thickness (3 to 10  $\mu\text{m}$ ) of the liquid crystal 3 used in the case where the reflection-type color liquid crystal display apparatus is assembled later.

[0036]

10 Here, as a process method for forming the uneven portion 24 on the second transparent insulation substrate 21, the sand blast method as shown in Fig. 12 is used to form the uneven portion 24. That is, on a surface opposite to the liquid crystal 3 of the second transparent insulation 15 substrate 21, the uneven portion 24 is formed by blowing a ground powder 19 from the grinding nozzle 18. In this case, the powder diameter of the grinding powder 19, and the blowing speed is adjusted so that the roughness and the depth of the uneven portion 24 is controlled.

20 [0037]

Furthermore, as another processing method for forming the uneven portion 24 on the second transparent insulation substrate 21, the photo-etching method as shown in Fig. 8 is used. That is, after a resist film 20 is formed at random 25 on the surface of the second transparent insulation film 21 opposite to the liquid crystal 3, the uneven portion 24 is formed by the dry etching and the photo-etching by using this resist film 20 as a mask. In this case, since a highly

fine mask can be formed by forming the resist film 20 with the photolithography method, so that the roughness and the depth of the uneven portion 24 can be controlled to desired range.

5 [0038]

Next, as shown in Fig. 6(d), an acryl film or a polyimide film is formed by such as the SOG (Spin On Glass) method or the printing method, so that a flattened film 25 is formed to cover the uneven portion 24 of the second 10 transparent insulation film substrate 21. As a consequence, light scattering means is formed by the uneven portion 24 and the flattened film 25. Next, an ITO film is formed on the whole surface of the substrate 21 by the sputtering method to form a common opposite electrode 22. Then, a 15 liquid crystal orientation layer 23 is formed of polyimide on the opposite electrode 22.

Through such a procedure, the opposite substrate 2 is formed.

[0039]

20 Next, the reflection-type color liquid crystal display apparatus is completed which has a structure as shown in Figs. 1 and 2, by sandwiching a liquid crystal 3 formed of, for example, a nematic liquid crystal between the liquid crystal driving element formation substrate 1 and the 25 opposite substrate 2 obtained in the above process to arrange the uneven portion 24 of the opposite substrate 2 to be placed on the side of the liquid crystal 3.

[0040]

In this manner, in the reflection-type color liquid crystal display apparatus having a structure of the first embodiment, the opposite substrate 2 which comprises a second transparent insulation substrate 21 formed of glass or the like and having an uneven portion 24 on the side of the liquid crystal 3, a flattened film 25 formed of acryl or polyimide so as to cover the uneven portion 24 of the second transparent insulation substrate 21, a common opposite electrode 22 formed of ITO or the like on the flattened film 25 and a liquid crystal orientation layer 23 is formed, and the light scattering means is constituted of the uneven portion 24 and the flattened film 25 with the result that the starting point of scattering on the opposite substrate 2 can be set to a point near from the liquid crystal 3 thereby making it possible to decrease the generation of undesirable light such as mixed color light or uncontrollable light.

Furthermore, in the reflection-type color liquid crystal display apparatus having a structure of the first embodiment, since the light scattering means is constituted by forming the uneven portion 24 of the second transparent insulation substrate 21 on the side of the liquid crystal 3, the light scattering means can be provided in an easy method.

Consequently, in the case where a white color is displayed by the light scattering means, contrast and visibility can be improved.

[0041]

◇Second Embodiment

Fig. 9 is a sectional view showing a structure of the

reflection-type color liquid crystal display apparatus according to a second embodiment of the present invention. The point in which the reflection-type color display apparatus is largely different from the structure of the 5 first embodiment described above is that the uneven portion 40 has decreased degree of the unevenness, the formation of 10 the flattened film 25 is made unnecessary.

That is, in the second embodiment, as shown in Fig. 9, the uneven portion 40 formed on the side of liquid crystal 3 10 of the second transparent insulation substrate 21 is such that the height difference between the top portion 40A and the valley portion 40B is smaller than the case of the first embodiment, and is formed to a thickness of approximately 1  $\mu\text{m}$  or less thereby constituting light scattering means. On 15 the uneven portion 40, a common opposite electrode 22 is formed of ITO or the like, and on the opposite electrode 22, a liquid crystal orientation layer 23 is formed of polyimide or the like respectively. In this manner even when the 20 light scattering means is constituted by forming an uneven portion 40 having a small degree of unevenness, the light scattering means can display a sufficient function.

[0042]

As the process method for forming the uneven portion 40, in the same manner as the case of the first embodiment, the 25 sand blast method shown in Fig. 7 and the photo-etching method shown in Fig. 8 can be used. In particular, in the case of the second embodiment, it is desirable to use the photo-etching method which enables a high precision

processing.

Except for the above, the second embodiment is approximately the same as the first embodiment.

Consequently, in Fig. 9, each portion corresponding to the 5 constituent portion of the first embodiment shown in Figs. 1 and 2 are denoted by same reference numerals, and an explanation thereof will be omitted.

[0043]

10 In this manner, with the structure of the second embodiment, approximately the same advantage can be provided as has been described in the first embodiment.

In addition, according to the structure of the second embodiment, the planarization (formation of a flattened film) is further made unnecessary.

15 [0044]

◇Third Embodiment

Fig. 10 is a sectional view showing a structure of a reflection-type color liquid crystal display apparatus according to a third embodiment of the present invention.

20 The point in which the structure of the reflection-type color liquid crystal display apparatus according to the third embodiment of the invention is largely different from the structure of the first embodiment lies in the fact that the uneven insulation film 41 is formed on the surface of 25 the transparent insulation substrate 21, the formation of the uneven configuration on the substrate 21 itself is made unnecessary so that the light scattering means is constituted.

That is, in the third embodiment, as shown in Fig. 10, for example, an acryl film and a polyimide film are formed on the side of the liquid crystal 3 on the surface of the second transparent insulation substrate 21 to form the uneven insulation film 41. The height difference between the top portion 41A and the valley portion 41B of the uneven insulation film 21 is formed on the same degree as the second embodiment. On the uneven insulation film 41, a common opposite electrode 22 is formed of ITO or the like, and on the opposite electrode 22, a liquid crystal orientation layer 23 is formed of polyimide or the like. In this manner, even when the light scattering means is constituted of the uneven insulation film 41 formed on the second transparent insulation film 21, the light scattering means can display a sufficient function.

[0045]

As a method for forming the uneven insulation film 41, a resist is applied on the surface of the second transparent insulation substrate 21 at random after an acryl film or a polyimide film is formed by the SOG method or the printing method on the second transparent insulation substrate 21, then the uneven insulation film 41 can be formed by etching the acryl film or the polyimide film using the resist as a mask and removing the resist.

25 [0046]

In this manner, with the structure of the third embodiment, approximately the same advantage can be obtained with the constitution of the first embodiment.

In addition, the formation of the uneven portion can be made easy in the constitution of the third embodiment than the formation thereof on the substrate 21 itself.

[0047]

5 ◇Fourth Embodiment

Fig. 11 is a sectional view showing a structure of a reflection-type color liquid crystal display apparatus according to the fourth embodiment of the present invention. The point in which the reflection-type color liquid crystal 10 display apparatus according to the fourth embodiment of the present invention is largely different from the structure of the third embodiment described above lies in the fact that the uneven insulation film 41 formed on the surface of the transparent insulation substrate 21 and a light scattering 15 auxiliary film 42 having a different refractive index constitute the light scattering means.

That is, in the fourth embodiment, as shown in Fig. 16, an uneven insulation film 41 formed on the surface of the second transparent insulation film 21 on the side of the 20 liquid crystal 3 and a scattering auxiliary film 42 formed on the uneven insulation film 41 and having a refractive index different from the uneven insulation film 41 constitute the light scattering means. In this case, the relation between the refractive index  $n_1$  of the uneven 25 insulation film 41 and the refractive index  $n_2$  of the scattering auxiliary film 42 is set to be  $n_1 > n_2$ . On the scattering auxiliary film 42, a common opposite electrode 22 is formed of ITO or the like and, on the opposite electrode

22, a liquid crystal orientation layer 23 is formed of polyimide or the like. Even when the light scattering means is constituted with the combination of the uneven insulation film 41 and the scattering auxiliary film 42 which have 5 different refractive index each other, the light scattering means can show a sufficient function.

[0048]

In this manner, with the structure of the fourth embodiment, the fourth embodiment can provide approximately 10 the same advantage as described in the third embodiment.

In addition, with the structure of the fourth embodiment, the fourth embodiment can control the degree of scattering with the scattering auxiliary film 42.

[0049]

15 ◇Fifth Embodiment

Fig. 12 is a sectional view showing a structure of a reflection-type color liquid crystal display apparatus according to a fifth embodiment of the invention. The point in which the structure of the reflection-type color liquid 20 crystal display apparatus which is the fifth embodiment of the present invention is largely different from the structure of the third embodiment is that the uneven insulation film formed on the surface of the transparent insulation substrate and the flattened film constitute the 25 light scattering means.

That is, in the present embodiment, as shown in Fig. 12, on the surface of the second transparent insulation substrate 21 on the side of the liquid crystal 3, for

example, an acryl film or a polyimide film is formed to form an uneven insulation film 41, and the uneven insulation film 41 is covered with the flattened film 25 to constitute the light scattering means. On the flattened film 25 the common 5 opposite electrode 22 is formed of ITO or the like, and on the opposite electrode 22, a liquid crystal orientation layer 23 is formed of polyimide or the like, respectively. In this manner, even when the uneven insulation film 41 and the flattened film 25 formed on the surface of the second 10 transparent insulation film 21 constitute the light scattering means, the light scattering means can show a sufficient function.

[0050]

In this manner, with the structure of the fifth 15 embodiment, the fifth embodiment can provide approximately the same advantage as described in the third embodiment.

[0051]

◇Sixth Embodiment

Fig. 13 is a sectional view showing a structure of a 20 reflection-type color liquid crystal display apparatus according to a sixth embodiment of the present invention. The point in which the structure of the reflection-type color liquid crystal display apparatus which is the sixth embodiment is largely different from the fifth embodiment 25 described above lies in the fact that an uneven insulation film formed on the transparent insulation substrate and a flattened and scattering auxiliary film formed on the uneven insulation film constitute the light scattering means.

That is, in the sixth embodiment, as shown in Fig. 13, an acryl film or a polyimide film is formed on the surface of the second transparent insulation substrate 21 on the side of the liquid crystal 3 to form an uneven insulation film 41 is formed so that the uneven insulation film 41 is covered, and then a flattened and a scattering auxiliary film 43 is formed on the uneven insulation film 41 to constitute the light scattering means. On the flattened and scattering auxiliary film 43, the common opposite electrode 10 22 is formed of ITO or the like, and on the opposite electrode 22, a liquid crystal orientation layer 23 is formed of polyimide or the like, respectively. In this manner, even when the light scattering means is constituted of the uneven insulation film 41 formed on the surface of 15 the second transparent insulation film 21 and the flattened and scattering auxiliary film 43 formed on the uneven insulation film 41, the light scattering means can show a sufficient function.

[0052]

20 In this manner, with the structure of the sixth embodiment, the sixth embodiment can provide approximately the same advantage.

[0053]

Thus, the embodiment of the present invention has been 25 described in detail referring to the drawings, but the concrete structure is not restricted to the above embodiment. The change in the design which is not deviated from the scope of the gist of the present invention is also included

in the present invention. For example, as a switching element for driving the liquid crystal, there is shown an example using the TFT as the switching element for driving the liquid crystal. The present invention is not restricted thereto. Other switching element such as a diode or the like can be used.

[0054]

Furthermore, as the liquid crystal driving element formation substrate, a transparent insulation substrate is used to form a switching element thereon. The present invention is not restricted thereto. Other substrate such as the semiconductor substrate formed of the silicon substrate or the like is used to form the switching element. Furthermore, one example is shown with respect to the conditions such as method for forming each kind of insulation film and conductive film or the like, the thickness thereof and the like, it can be modified according to purpose or use.

[0055]

20 [Effect of the Invention]

According to the reflection-type color liquid crystal display apparatus of the present invention, the light scattering means is provided on the side of the liquid crystal of the opposite substrate, so that the starting point of scattering in the opposite substrate is set to a point near to the liquid crystal. Thus, the generation of undesired light such as mixed color light, uncontrollable light or the like can be decreased.

In the method for manufacturing a reflection-type color liquid crystal display apparatus of the present invention, the light scattering means can be provided with a simple method because the light scattering means is constituted by 5 forming the uneven portion on the side of the liquid crystal of the opposite substrate.

Consequently, in the case where the light scattering means is provided to display a white color, contrast and visibility can be improved.

10 [BRIEF DESCRIPTION OF THE DRAWING]

[Fig. 1]

Fig. 1 is a plan view showing a structure of a reflection-type color liquid crystal display apparatus according to a first embodiment of the present invention.

15 [Fig. 2]

Fig. 2 is a sectional view taken along line A-A of Fig. 1.

[Fig. 3]

Fig. 3 is a sectional view for schematically explaining 20 a reason why contrast is improved in the reflection-type color liquid crystal display apparatus according to the first embodiment.

[Fig. 4]

Fig. 4 is a sectional view for schematically explaining 25 a reason why visibility is improved in the reflection-type color liquid crystal display apparatus according to the first embodiment.

[Fig. 5]

Fig. 5 is a group of views showing a method for manufacturing a reflection-type color liquid crystal display apparatus in order of steps.

[Fig. 6]

5 Fig. 6 is a group of views showing a method for manufacturing a reflection-type color liquid crystal display apparatus in order of steps.

[Fig. 7]

10 Fig. 7 is a model view showing one example of a process method for forming the light scattering means in the method for manufacturing the reflection-type color display apparatus according to the first embodiment.

[Fig. 8]

15 Fig. 8 is a sectional view showing another example of the process method for forming the light scattering means in the method for manufacturing the reflection-type color liquid crystal display apparatus according to the first embodiment.

[Fig. 9]

20 Fig. 9 is a sectional view showing a structure of the reflection-type color liquid crystal display apparatus according to a second embodiment of the present invention.

[Fig. 10]

25 Fig. 10 is a sectional view showing a structure of the reflection-type color liquid crystal display apparatus according to a third embodiment of the present invention.

[Fig. 11]

Fig. 11 is a sectional view showing a structure of the

reflection-type color liquid crystal display apparatus according to a fourth embodiment of the present invention.

[Fig. 12]

Fig. 12 is a sectional view showing a structure of the 5 reflection-type color liquid crystal display apparatus according to a fifth embodiment of the present invention.

[Fig. 13]

Fig. 13 is a sectional view showing a structure of the reflection-type color liquid crystal display apparatus 10 according to a sixth embodiment of the present invention.

[Fig. 14]

Fig. 14 is a sectional view showing a structure of one example of a conventional reflection-type color liquid crystal display apparatus.

15 [Fig. 15]

Fig. 15 is a sectional view showing a structure of another example of a conventional reflection-type color liquid crystal display apparatus.

[Fig. 16]

20 Fig. 16 is a sectional view for schematically explaining a reason why visibility is lowered in the conventional reflection-type color liquid crystal display apparatus.

[Fig. 17]

25 Fig. 17 is a sectional view for schematically explaining a reason why contrast is lowered in the conventional reflection-type color liquid crystal display apparatus.

[Fig. 18]

Fig. 18 is a sectional view for schematically explaining a reason why contrast is lowered in the conventional reflection-type color liquid crystal display apparatus.

[Description of the numerals]

- 1 liquid crystal driving element formation substrate
- 2 opposite substrate
- 3 liquid crystal
- 10 4 first transparent insulation substrate
- 5 gate electrode
- 6 reflection plate
- 7 gate insulation film
- 8 semiconductor layer
- 15 9 drain electrode
- 10 source electrode
- 11,14 insulation protection film
- 12 black matrix
- 13 color filter
- 20 15 pixel electrode
- 16, 23 liquid crystal orientation layer
- 17 contact hole
- 18 grinding nozzle
- 19 ground powder
- 25 20 resist film
- 21 second transparent insulation film
- 22 opposite electrode
- 24, 40 uneven portion

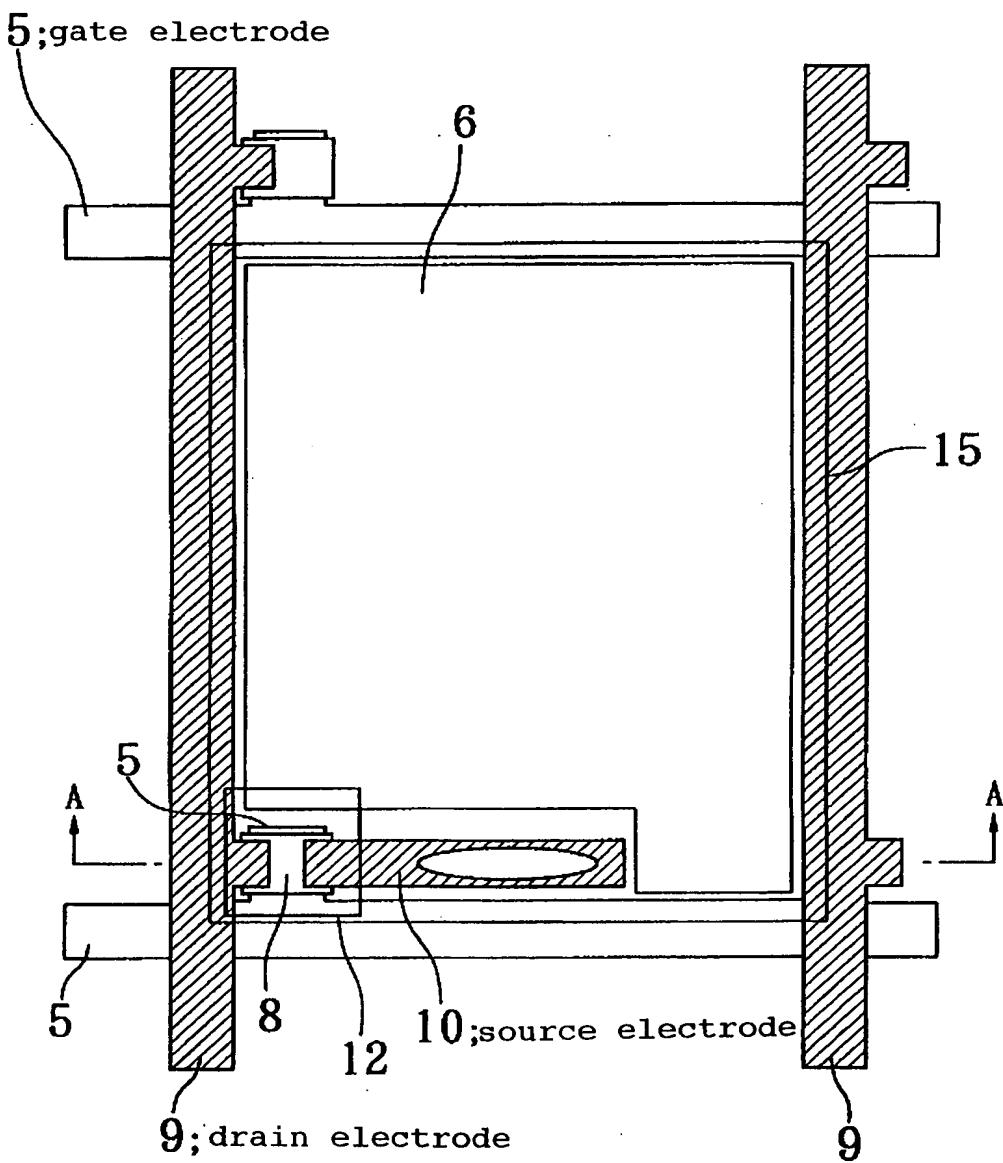
- 24A, 40A, 41A top portion
- 24B, 40B, 41B valley portion
- 25 flattened film
- 30 specific incident light region
- 5 31A - 31C light incident on the specific incident light region
- 31X, 35 abnormal light
- 32 front surface position
- 33 light which is directed toward the front surface
- 10 position
- 34 light which is directed in a slanting direction
- 41 uneven insulation film
- 42 light scattering auxiliary film
- 43 flattened and scattering auxiliary film

15

[Name of Document]

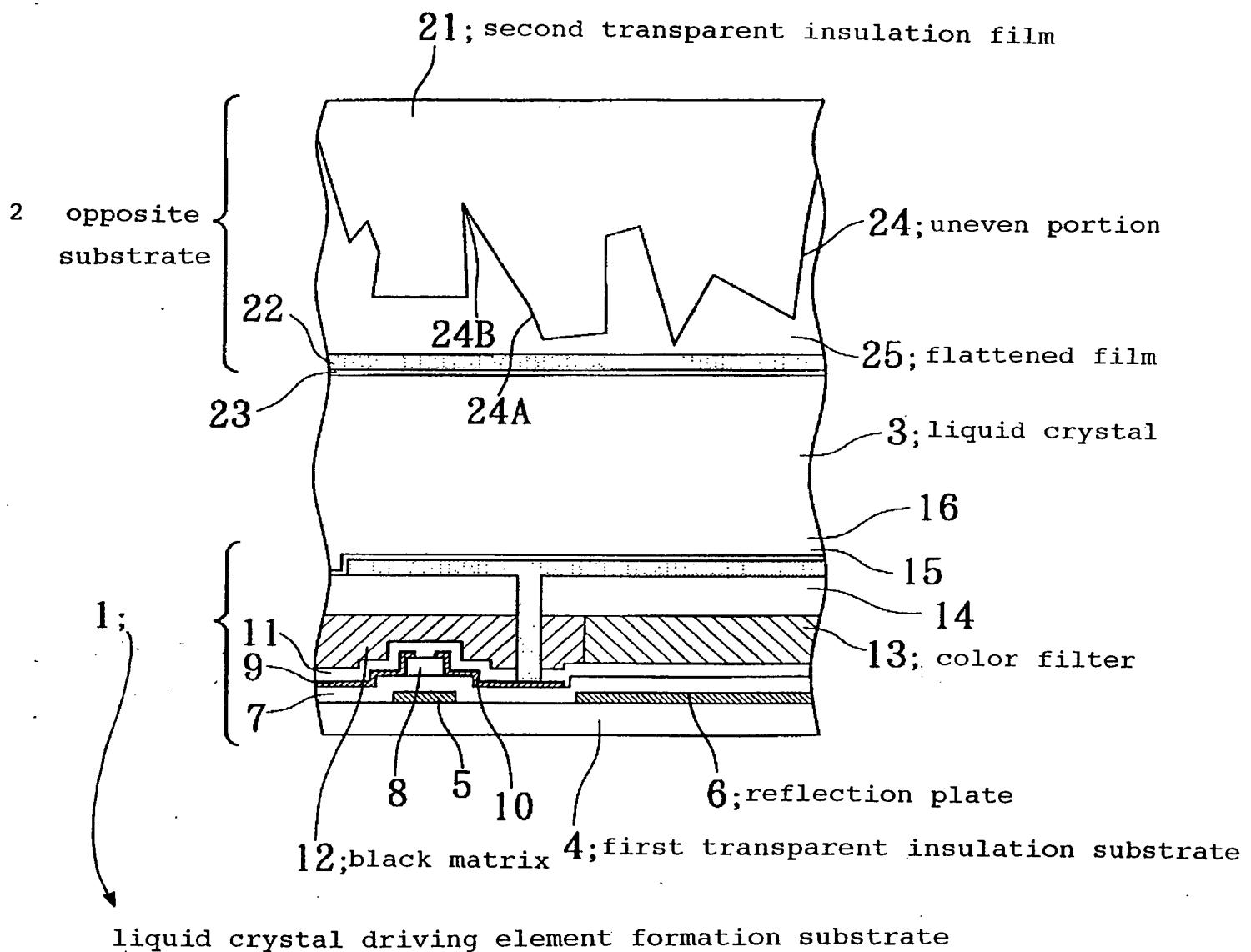
Drawing

[Fig. 1]

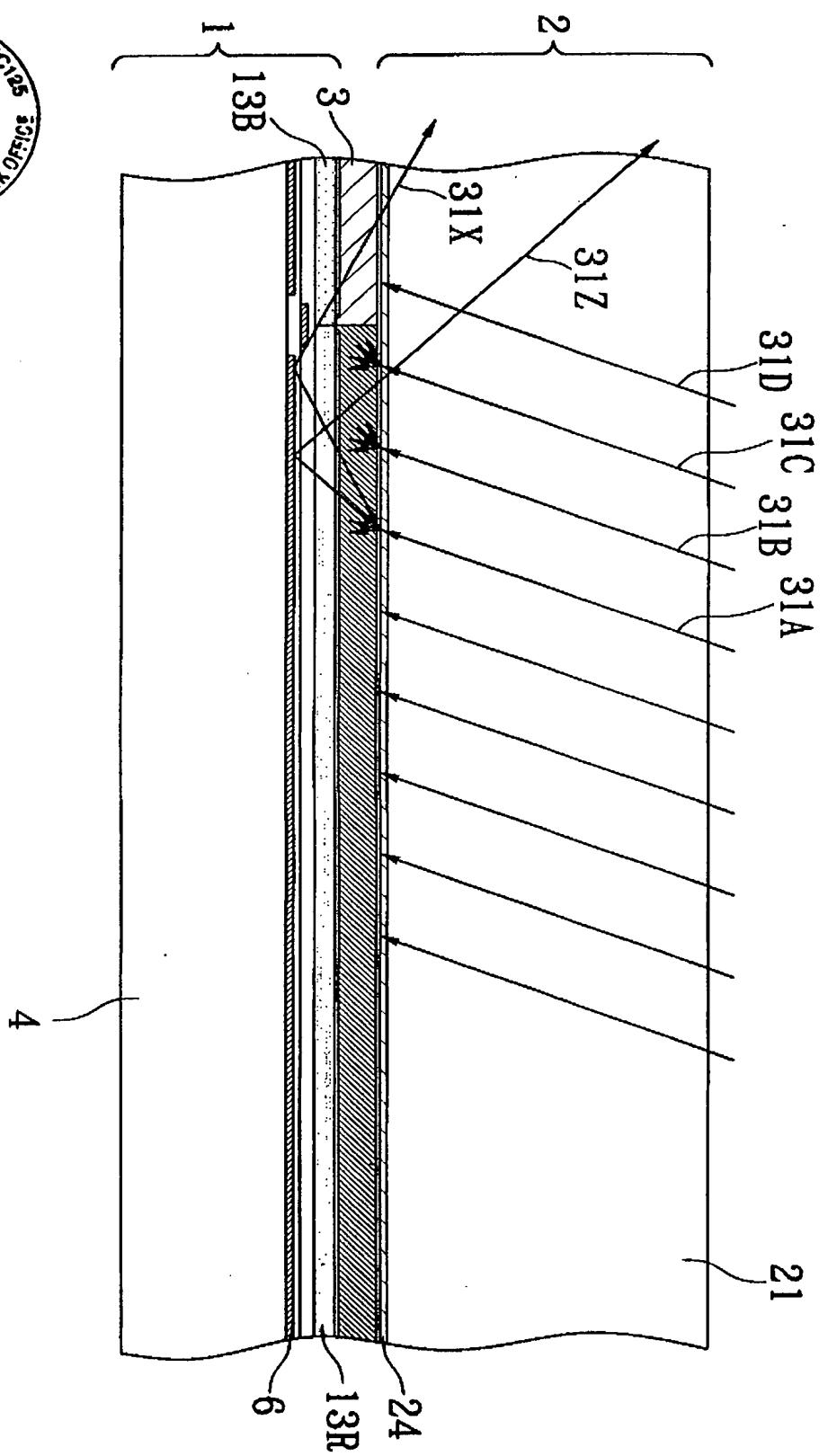




[Fig. 2]



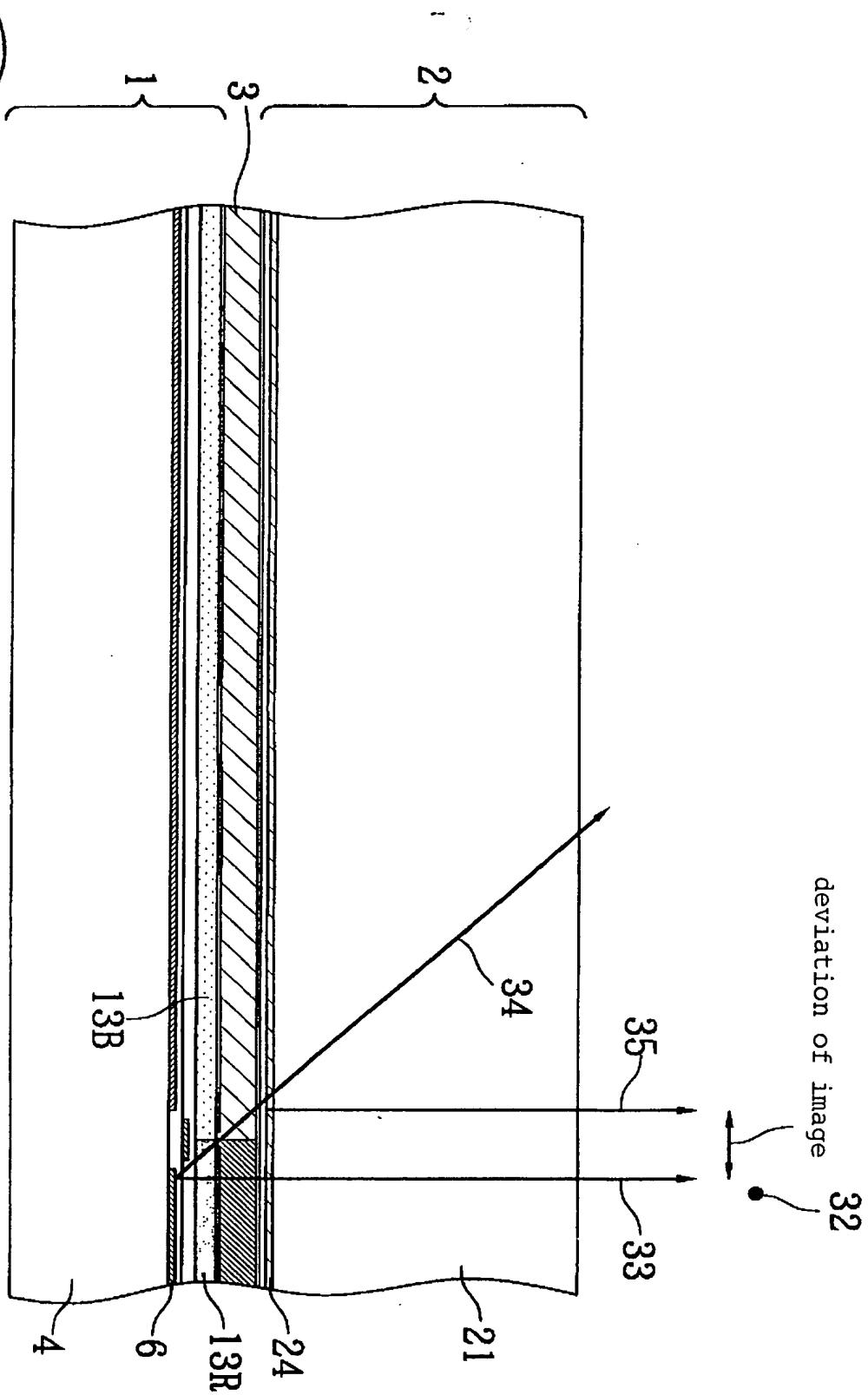
[Fig. 3]



30; the specific incident light region which causes the generation of color mixing or uncontrollable light



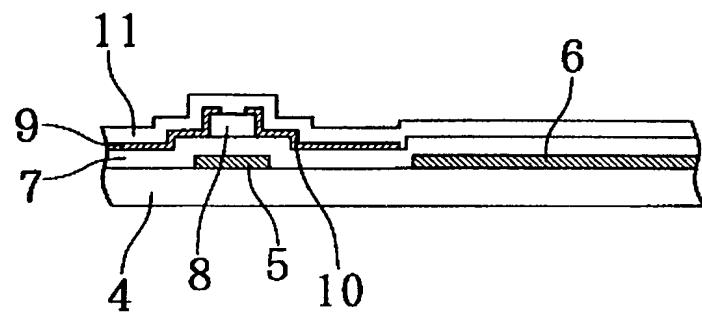
[Fig. 4]



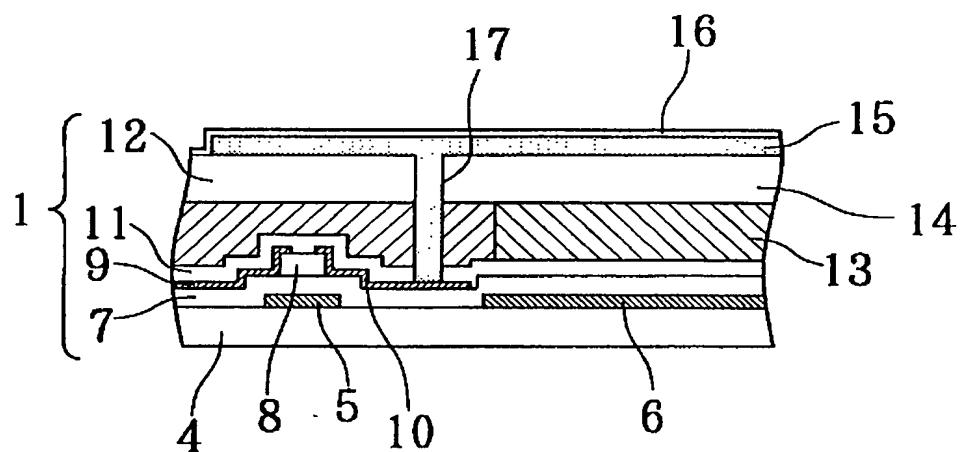
[Fig. 5]



(a)



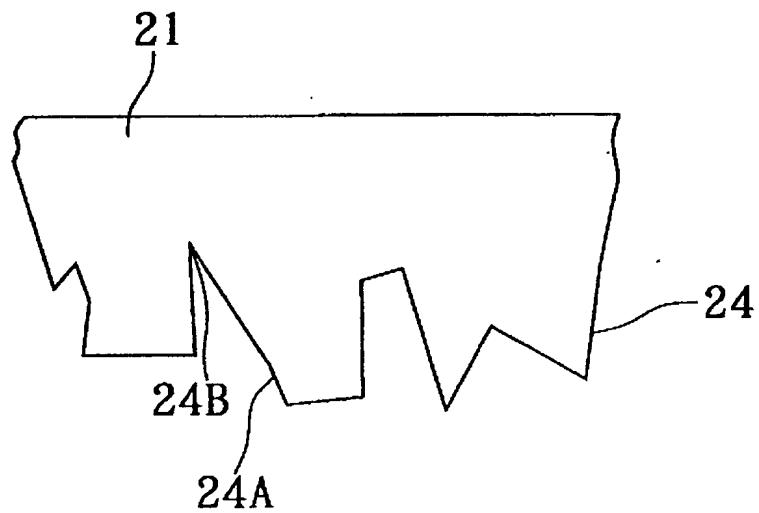
(b)



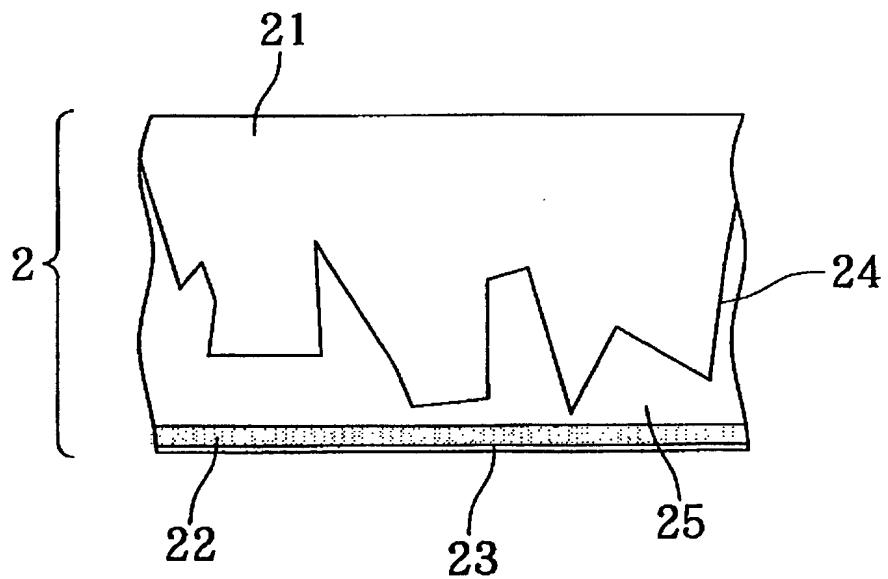
[Fig. 6]



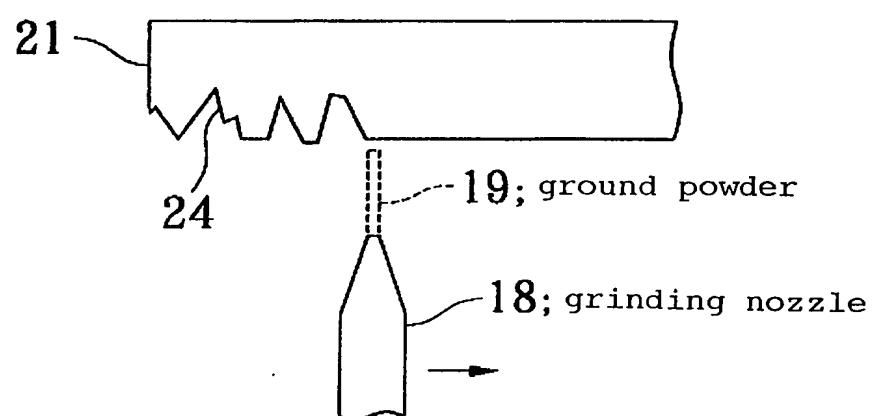
(c)



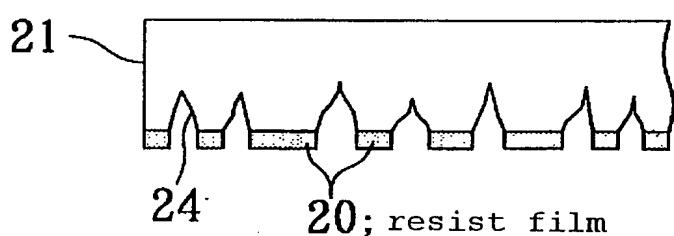
(d)



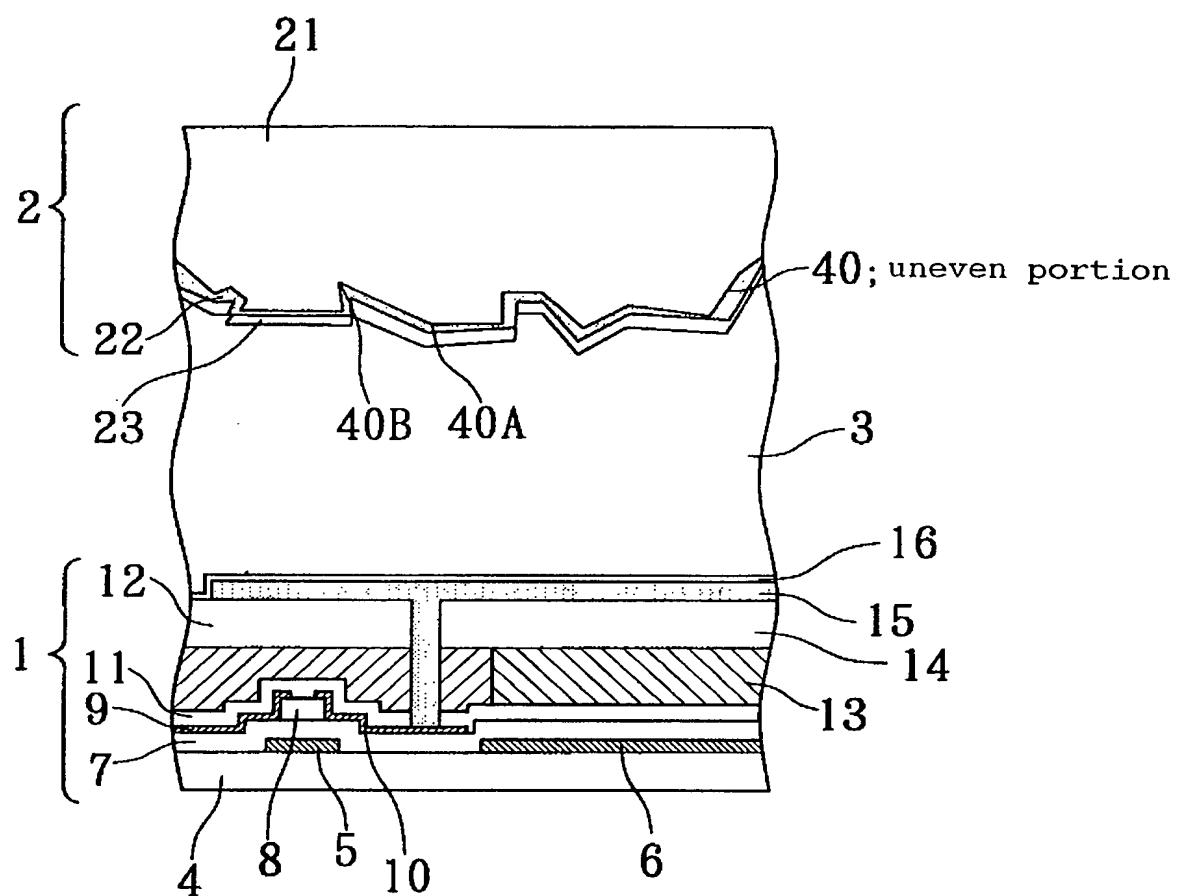
[Fig. 7]



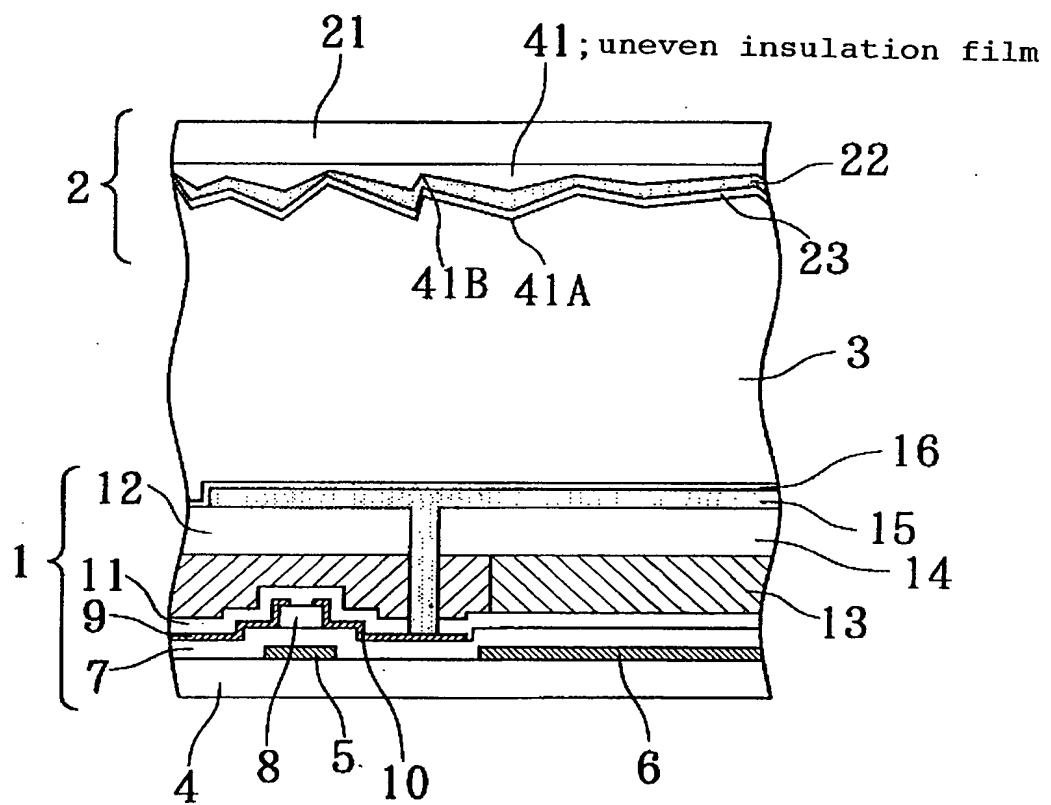
[Fig. 8]



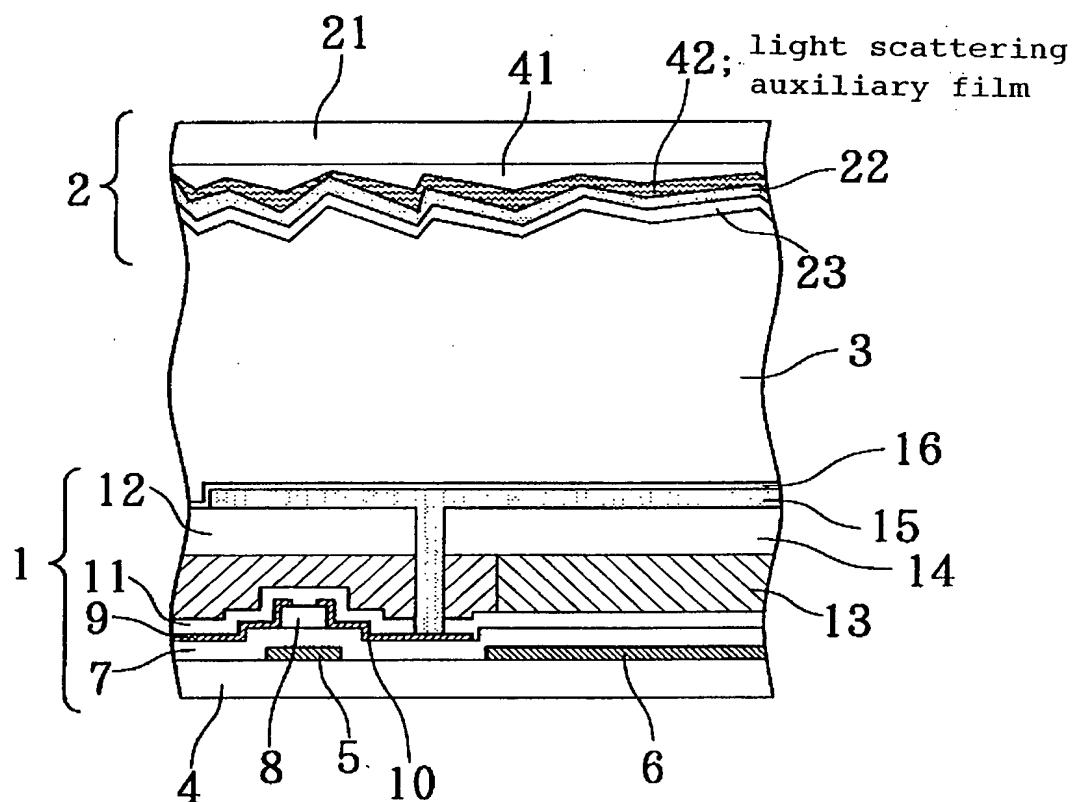
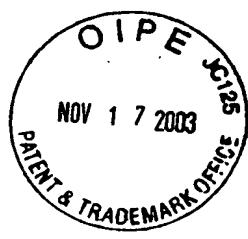
[Fig. 9]



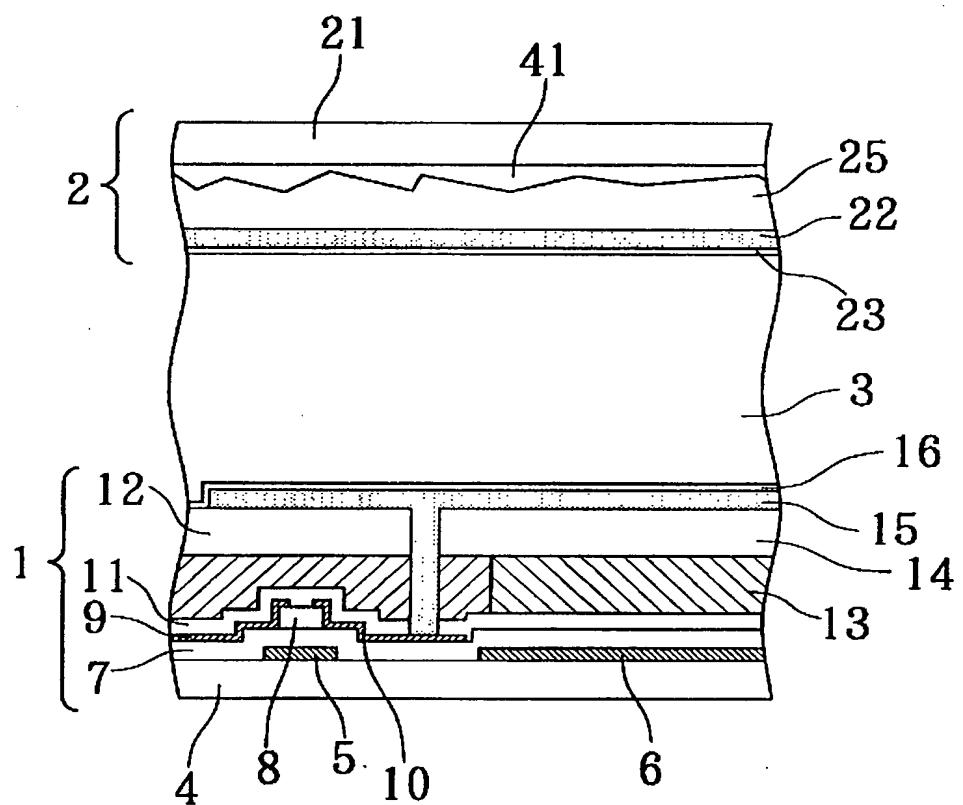
[Fig. 10]



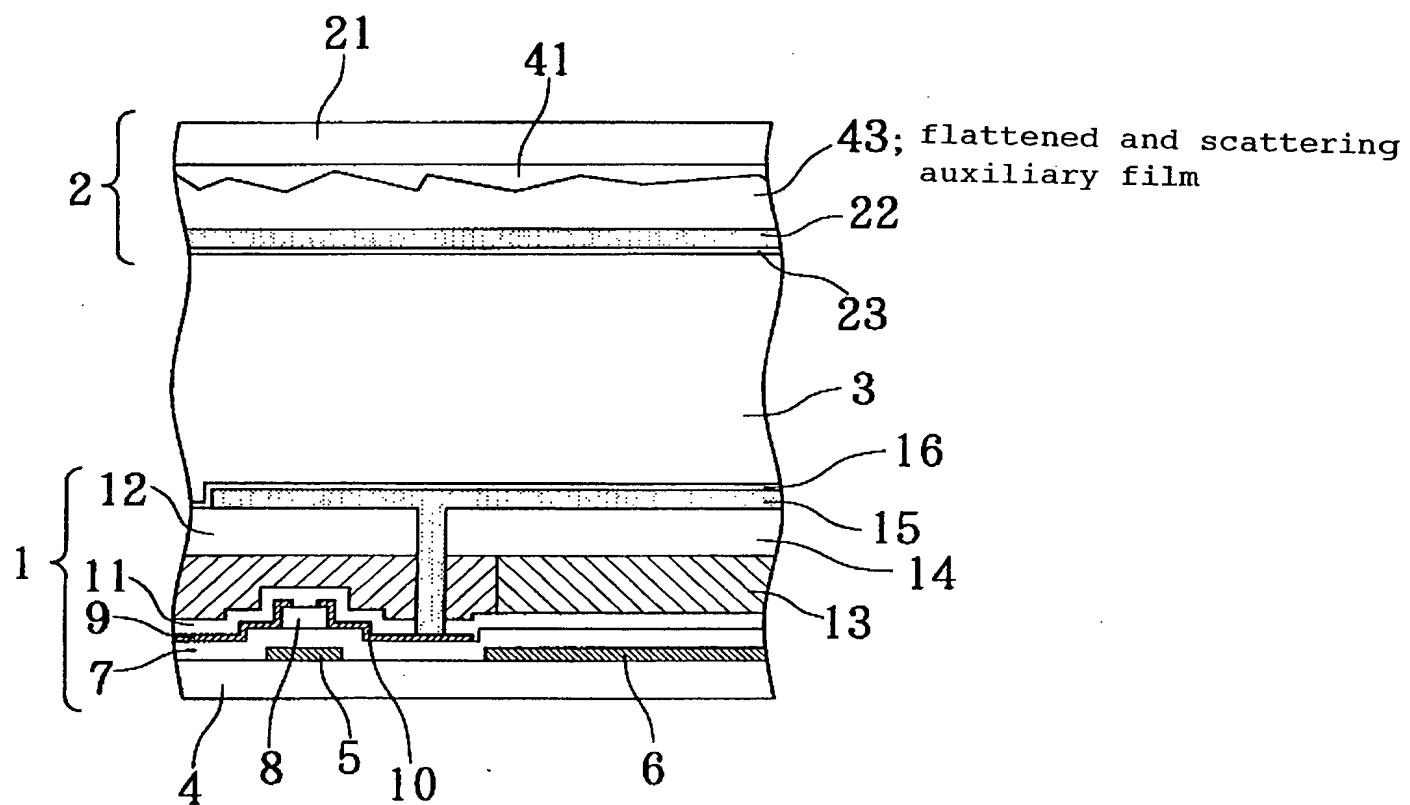
[Fig. 11]



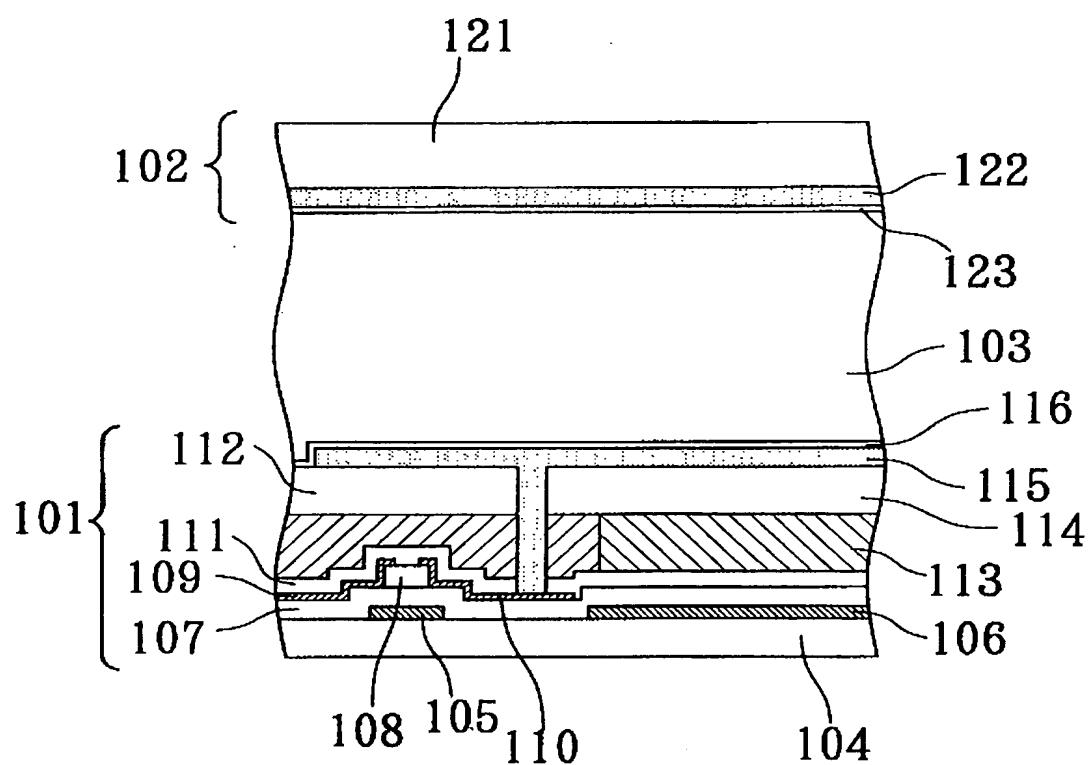
[Fig. 12]



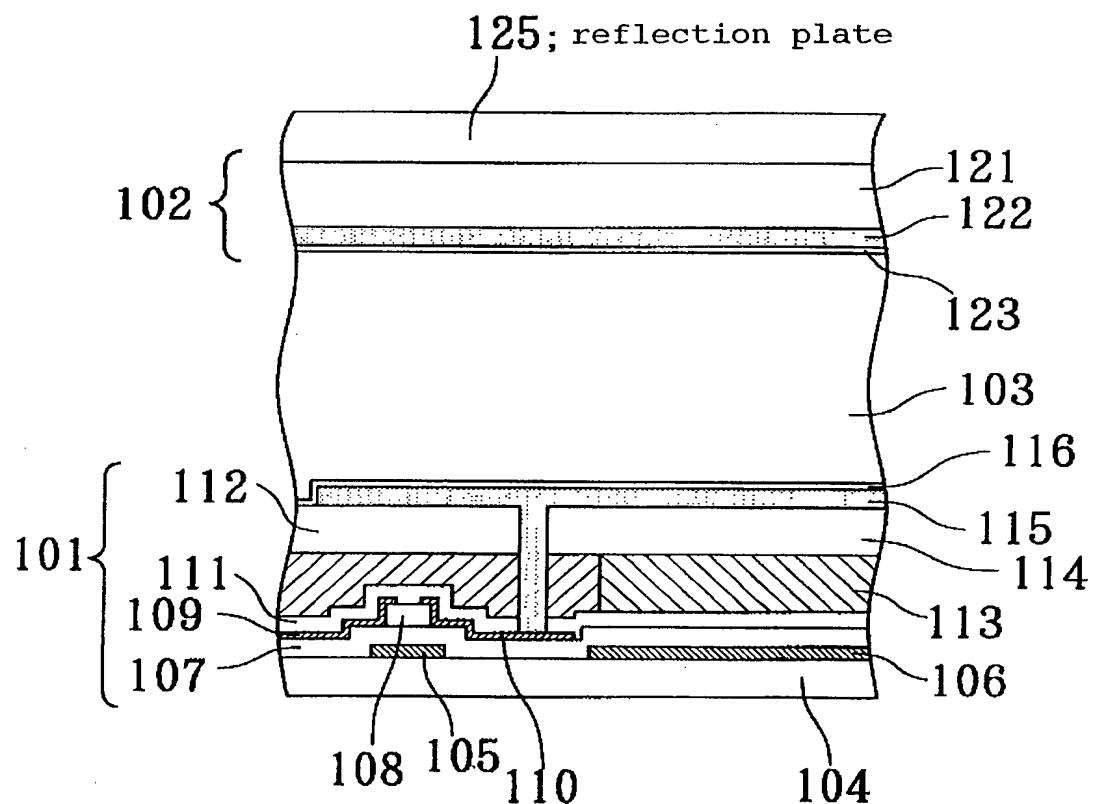
[Fig. 13]



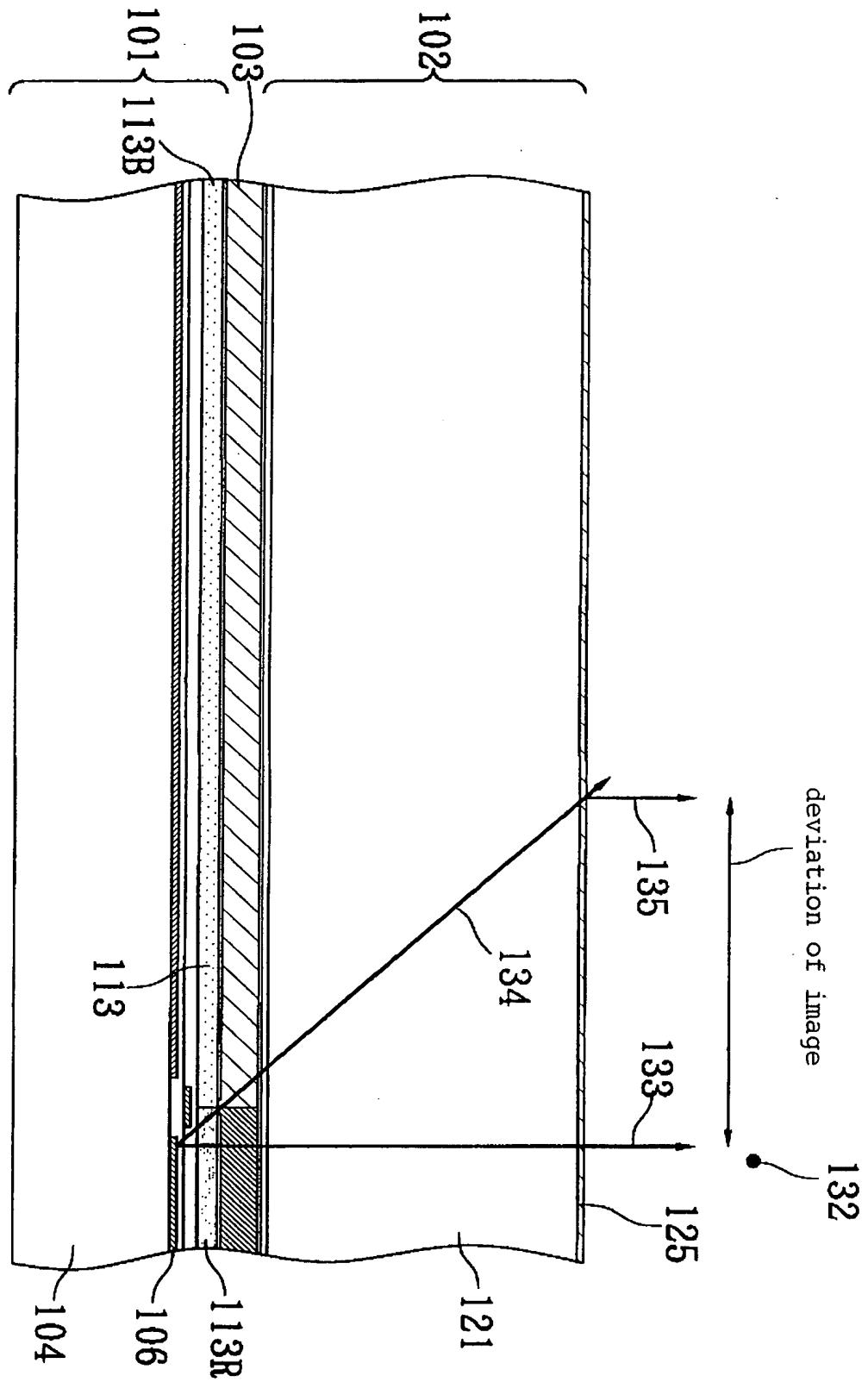
[Fig. 14]



[Fig. 15]

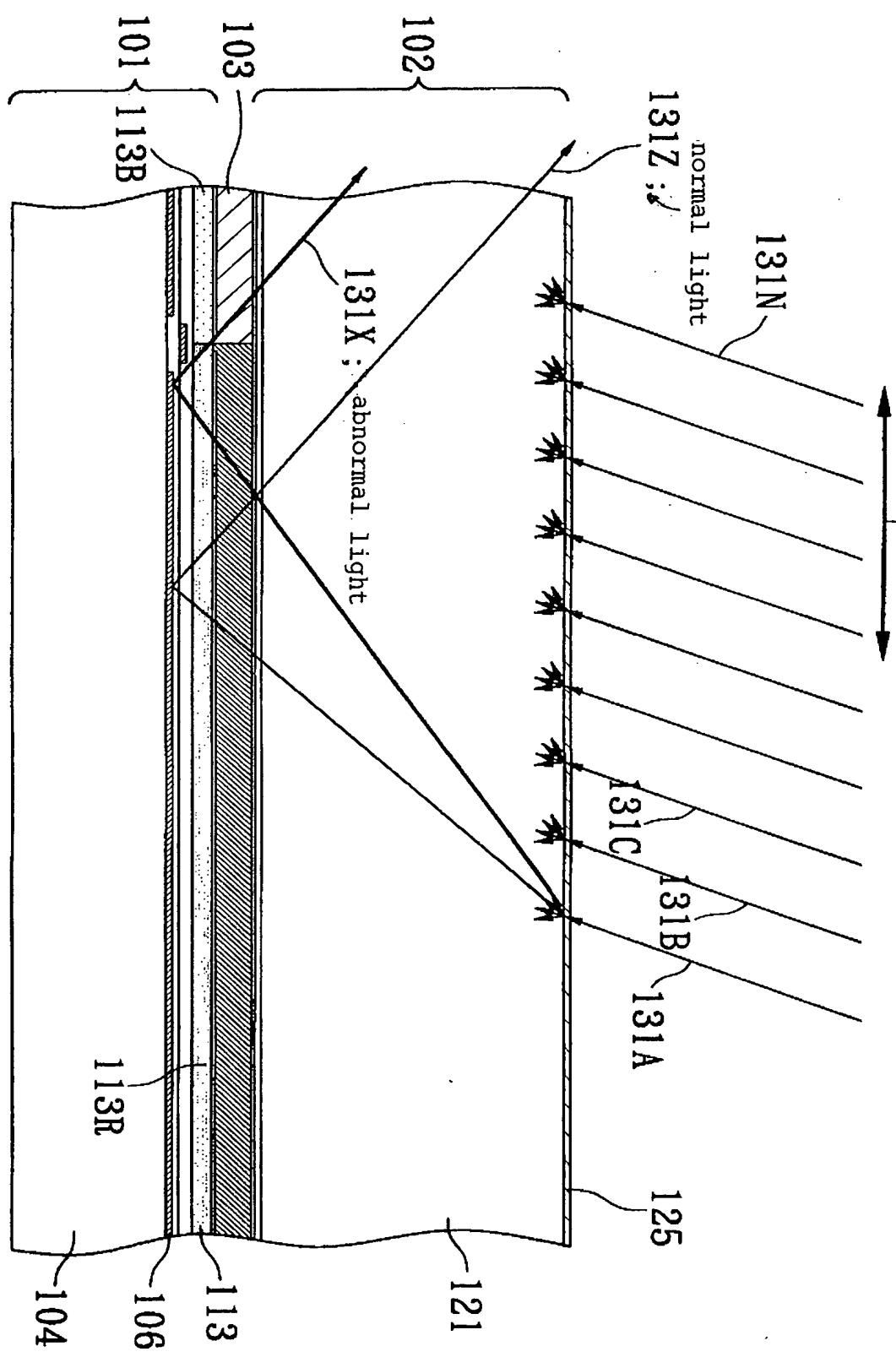


[Fig. 16]

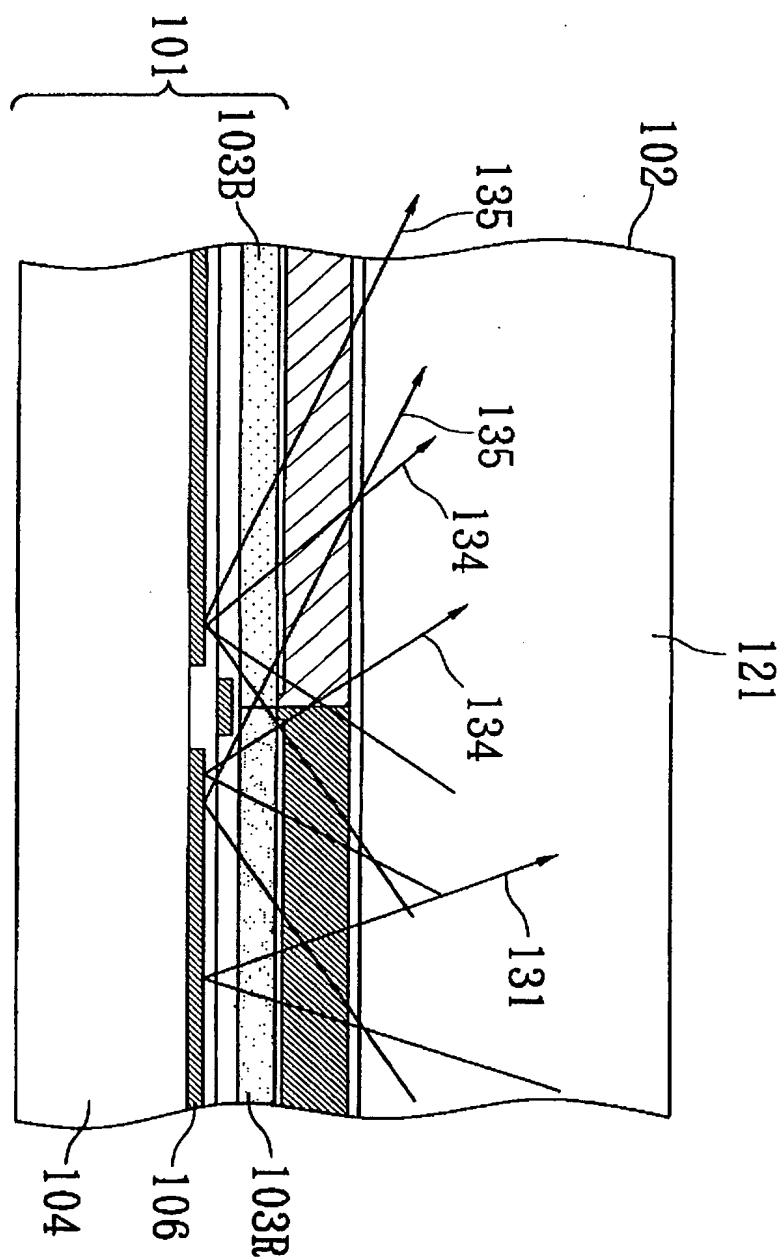




[Fig. 17]



[Fig. 18]





[NAME OF THE DOCUMENT] Abstract

[Abstract]

[Object] Contrast and visibility can be improved in a case where a white color is displayed by providing light scattering means.

5

[Means for solving the Problem]

An opposite substrate of a reflection-type color liquid crystal display apparatus has a second transparent insulation substrate 21 made of glass or the like wherein an uneven portion 24a is formed on the side of a liquid crystal 10. A flattened film 25 made of acryl, polyimide or the like is formed to cover the uneven portion 24 of the second transparent insulation substrate 21. A common opposite electrode 22 made of ITO or the like is formed on the 15 flattened film 25. A liquid crystal orientation layer 23 made of polyimide or the like is formed on the opposite electrode 22. A light scattering means is constituted of said uneven portion 24 and the flattened film 25.

[Selected Drawings] Fig. 2